INTERNAL CONVERSION ELECTRON SPECTRA OF LONG-LIVED TIN ISOTOPES

BY

JOHN WILLIAM MIHELICH

A.B., Colorado College, 1942
M.S., University of Illinois, 1947

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN PHYSICS
IN THE GRADUATE COLLEGE OF THE
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Introduction

The recent availability of electromagnetically enriched isotopes has made possible a more accurate analysis of the radiations of tin. Four samples enriched in Sn^{116}, Sn^{118}, Sn^{120}, and Sn^{122}, respectively, were obtained and bombarded in the Oak Ridge pile for a period of one month. The radiations from the excited nuclei formed by neutron capture were studied by means of permanent magnet photographic beta-ray spectrometers, a variable field Geiger counter spectrometer, and Geiger counter absorption techniques.

Discussion Of Results

A 14 day isomeric activity formerly assigned to Sn^{119m} (1) has been definitely assigned to Sn^{117m}. An exposure on a photographic spectrograph showed conversion lines corresponding to gamma rays of energy 159 and 162 kev, both sets of lines decaying with the 14 day half life. Apparently the two gamma rays were in cascade. Photometry of the film recording the conversion lines allowed a measure of the line intensities. The K/L ratio of the lines of the 159 kev gamma ray was consistent with it being a 2^4 magnetic transition, and it was concluded that this transition had the 14 day lifetime. This gamma ray was highly converted so that the sum of the intensities of all its conversion lines approximated closely the number of transitions. Thus, one could calculate the K conversion coefficient for the second (162 kev) transition and determine its multipole order. It was probably 2^1 magnetic. The intermediate state was undoubtedly very short lived ($\sim 10^{-9}$ seconds). These results are in accord with the one particle shell theory of M. G. Mayer (2), the levels involved being $(1h_{11/2})$, $(2d_{3/2})$, and $(3s_{1/2})$. No evidence of a cross-over transition was detected.

A 175 day isomeric state of Sn^{119m} was found, and the decay attributed to a 69 kev transition identified as 2^4 magnetic from the K/L ratio determined in a variable field spectrometer. The conversion lines of this gamma ray were first detected photographically, but they were of very low intensity, due to the small isotopic capture cross section of Sn^{118}. Since the measured ground state of Sn^{119} is $(S_{1/2})$, in order to fulfill parity and angular momentum requirements, the shell theory would suggest the existence of a second transition in the Sn^{119} decay.

The previously reported 28 hour, .360 Mev β^- activity in Sn^{121} was confirmed. No conversion lines were in evidence.

A heterogeneous source enriched in Sn^{123} to the extent of only 45.8% showed a long lived activity, probably the 130 day half life reported previously (1) (3). However, there was apparently a longer lived activity present, since, at the time this report was written, the decay curve was still flattening. This was due, possibly, to a 400 day activity (1). Conversion lines corresponding to K and L electrons of a 393 kev gamma ray were detected photographically. Within the limits of a rather large experimental error, these lines decayed with a lifetime of approximately 130 days and of the same order as that of the continuous beta ray background. The K/L ratio was consistent with 2^4 electric or 2^5 magnetic radiation. The lifetime for the former would be $\sim 10^{-1}$ seconds, and for the latter, $\sim$ 1000 days.

A decomposition of the decay curves permitted the comparison of the isotopic capture cross sections. By using the value .05 barn for the cross section of Sn^{120} (4), the values for Sn^{116}, Sn^{118}, and Sn^{122} were determined as .09 barn, .004 barn, and .09 barn, respectively.

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VITA

John William Mihelich was born January 2, 1922 in Colorado Springs, Colorado. He attended elementary and high school in that city. In 1942 he received the Bachelor of Arts degree (Magna cum Laude) from Colorado College. He was in the Army Signal Corps from November 1942 until February 1946, serving as a ground radar officer, and had overseas service in the Southwest Pacific Theatre. After release from active duty, he entered the Graduate College of the University of Illinois. He held a teaching assistantship from June 1946 until February 1949, at which time he accepted a research assistantship. Publications include "Radiations from Te^{121}" by R.D. Hill and J.W. Mihelich, Phys. Rev. 74, 1874 (1948). He is a member of Phi Beta Kappa, Sigma Xi, Delta Epsilon, and the American Physical Society.